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Editorial

Corrosion Effects on Durability of RC Structures

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1. Introduction and Scope

The corrosion of steel reinforcement is recognized as one of the most important degradation problems in reinforced concrete (RC) structures. Based on financial reports, huge amounts of money are spent annually on the maintenance, repair, and rehabilitation of existing structures to ensure their structural integrity. Several research studies of corrosion indicate its negative effect on the mechanical properties of both steel and concrete, the degradation of the bond between them, and subsequently, the entire reduction of mechanical performance of corroded RC elements. Nowadays, a significant percentage of the existing built environment is or will be at the end of its useful lifetime; hence, the estimation of the bearing capacity of corroded RC elements has become a relevant engineering task. In this framework, this Special Issue provides a forum for original research and critical reviews on assessing corrosion damage in reinforced structures.

2. Contributions

Five research papers have been published in Special Issue of *Metals* titled Corrosion Effects on the Durability of RC Structures. The collected articles deal with several aspects of the corrosion phenomenon in reinforced concrete, including the copper corrosion behavior in simulated concrete-pore solutions [1], the influence of microstructure on the corrosion resistance of steel bars and their fatigue behavior [2], the degradation of bond mechanism between steel and concrete [3,4], and the flexural capacity of corroded Prestressed Reinforced Concrete (PRC) beams [5].

The use of copper in the construction field is fully spread in residential electrical wiring and the transport of water, heating, natural gas, and refrigeration. Due to this, copper corrosion was studied through exposure to two different alkaline electrolytes (saturated $Ca(OH)_2$ and cement extract) to simulate concrete-pore environments [1]. The results indicate that the cement extract media is more aggressive to copper than saturated $Ca(OH)_2$. Moreover, in accordance with the calculated pitting index (PI), the corrosion attacks on the copper surface could be considered quasi-uniform. Overall, the experimental study concludes that even though there are similarities, such as the fact that model solutions attack the copper surface in a quasi-uniform manner, overall copper corrosion develops in different ways in each concrete-pore model solution [1].

As a targeted extension of a recent European research project 'NEW dual-phase steel REinforcing BARs for enhancing capacity and durability of antiseismic moment-resisting frames' (NEWREBAR) [6], M. Basdeki and C. Apostolopoulos conducted an experimental campaign investigating the corrosion resistance and fatigue behavior of two types of steel reinforcement: traditional tempcore steel and a new-generation hybrid steel with a microstructure in which a mixture of phases of martensite and ferrite coexist in a unique matrix. The outcomes reveal that the mechanical behavior of hybrid steel reinforcement is rather promising in the long term, even though, in reference conditions, it is of a lower class [2]. In addition, based on an existing quality material index that characterizes the mechanical performance of materials in quasi-static loadings, an extended

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damage material indicator for fatigue conditions is proposed for evaluating the overall mechanical performance of metallic materials, taking into account both strength capacity and ductility in the long term [2].

The structural performance of steel reinforcement plays a key role in the entire structural integrity of structures and, consequently, in the durability of reinforced concrete. Especially in the case of prestressed reinforced concrete (PRC) structures, the potential corrosion risks could be severe since steel reinforcements are already subjected to high amounts of stress and, consequently, their load-bearing capacity could abruptly decrease. M. Kioumarsi et al. [5] presented an extensive review of the available experimental research on the load-bearing capacity of corroded PRC beams. The outcomes demonstrate that corrosion in PRC beams results in pitting corrosion in the strands, developing stress concentration around the pits, which induces the premature failure of prestressing wires. Based on the collected results, a calibrated degradation law for the residual flexural strength of PRC beams in function with the mass loss of strands is introduced [5].

Besides the degradation of mechanical properties of materials, corrosion mainly reduces the structural capacity of reinforced concrete since it alters the steel–concrete interface and deteriorates the bond strength between them. From this perspective, K. Koulouris [3] conducted a broad experimental study focusing on the influence of stirrups spacing on the bond strength degradation in RC elements. The experimental outcomes indicate that the densification of stirrups limits concrete-cracking development through confinement, leading to higher bond strength values and delaying the degradation of bond loss as corrosion damage increases [3]. Given that the recommendations of Model Code 2010 refer to the presence or absence of stirrups (links) as an on–off criterion, the abovementioned experimental data were compared with the Model Code recommendations, combined with other available data from the literature [4]. A discretization of confinement levels is proposed, according to experimental data, to represent different cases of stirrups density often occurring in real RC elements, and predictive zones of residual bond strength in relation to either corrosion penetration or surface crack width were extracted. Furthermore, the outcomes demonstrate that the corrosion penetration depth is an appropriate assessment tool to correlate the residual bond strength with the corrosion level, whereas surface crack width on concrete is not yet an effective index since there are many factors affecting crack width [4].

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